APPENDIX A

Detailed Description of Methods

NORTHGATE STAKEHOLDERS GROUP

South Lot Water Quality Evaluation Report Appendices
May 11, 2004 Meeting Handouts from
Dept. of Planning and Development

Detailed Description of Methods

This appendix provides detailed description of the methods used to evaluate water quality treatment benefits for the south lot alternatives. The approach used involves four basic steps, including:

- Step 1 – Evaluate initial pollutant loadings
  - Method A – using Seattle Public Utilities (SPU) water quality data for the Downstream Defender located within the study basin
  - Method B – using published values of pollutant loading factors applied to land use distributions for each alternative
- Step 2 – Calculate actual pollutant loadings to south lot facilities
- Step 3 – Calculate mass of pollutants removed by south lot facilities
- Step 4 – Compare results in terms of:
  - TSS and Total Zn removed per year
  - TSS and Total Zn removed per acre per year.

The following text provides details on the methods, inputs, assumptions, and results for each step.

Step 1 – Initial Pollutant Loadings

As described in the main text, initial pollutant loadings are defined for this study to mean the average mass per year of TSS and Total Zn generated within the entire contributing area to the proposed south lot facilities. This term does not take into account pollutant removal which may occur upstream due to catch basins, detention ponds, wetlands, etc. Two methods were used to estimate the initial pollutant loadings in order to provide a basis for cross-comparing results. The first method, Method A, uses measured water quality data from within the study area for 18 storm events sampled. The second method, Method B, uses published loading factors for several urban land use types.

Method A uses SPU water quality data from 18 storms for the Downstream Defender located at the southwest intersection of NE 100th Street and 1st Avenue NE. Using these data, regression equations were developed to relate expected TSS and Total Zn loadings based on stormwater volume. The regressions were based on log-log transforms of the concentrations verses sampled volume with a linear trendline fit to the data. The resulting regression equations are as follows:

$$\text{Log (TSS)} = 0.9611\text{x Log (SV)} - 3.9525, \qquad R^2 = 0.6653 \qquad \text{Eq. 1}$$

$$\text{Log (Total Zn)} = 0.9611\text{x Log (SV)} - 3.9525, \qquad R^2 = 0.7165 \qquad \text{Eq. 2}$$

where TSS and Total Zn are loading values in units of kg/year and SV is stormwater volume in units of L.

SPU provided similar water quality data for another sampling location further downstream in the South Branch Thornton Creek basin at Fischer Place NE and NE 105th Street. SPU installed a Vortechnics device for testing stormwater treatment efficacy at this location, which receives runoff from approximately 25 acres of mostly residential and right-of-way land uses. A total of 20 storms were sampled. While water quality data for TSS and Total Zn concentrations were provided by SPU, corresponding flow data were not available. Therefore, the data could not be analyzed using the methods described above. However, it is important to note that the average influent concentrations for TSS and Total Zn were very similar between the Downstream Defender and Vortechnics sites. Concentrations for TSS and Total Zn at the Downstream Defender site were 75.8 mg/L and 0.12 mg/L, respectively, averaged over the sampling period. The respective concentrations at the Vortechnics site were 55.4 mg/L and 0.07 mg/L. This tight comparison of average concentrations indicates that, within the study area, given relatively large differences in contributing area and land use distributions, pollutant concentrations may be expected to be reasonably similar. Thus, Equations 1 and 2 are expected to be valid for the range of alternatives being evaluated.

Method B was described fully in the main report.

Step 2 – Actual Pollutant Loadings

Actual pollutant loadings (AL) are calculated using the following equation:

$$\text{AL} = (\text{IL} - \text{Pre}) \times \%\text{Div} \qquad \text{Eq. 3}$$

where IL is initial loading (kg/year), Pre is pollutant load removed by pretreatment (kg/year) and %Div is the percent of the stormwater which is diverted to the facility on an annual basis.

The Nationwide Urban Runoff Program (NURP) method for sizing wetponds was used to gauge the treatment efficiency of the wetlands which provide pretreatment. This method uses the ratio of basin volume (wetland volume in this case, V_b) to runoff volume. The wetlands V_b was estimated to be approximately 26,100 ft^3 based on information provided by SPU (personal communication with Chris Woelfel, April, 2004). V_r was computed as follows

$$V_r = (0.9*A_{imp}+.25*A_{tg}+.1*A_{tf}+.01*A_o)*R/12 \qquad \text{Eq. 4}$$

where V_r is volume of runoff in ft^3; A_{imp}, A_{tg}, A_{tf} and A_o are acres of impervious area, till grass, till forest, and outwash, respectively; and R is rainfall in inches (0.47 inches for the 6-month, 24-hour event).

Assuming that the area draining to the wetlands has a similar land use distribution as the entire area draining to the upstream end of the south lot, which covers approximately 670 acres, A_{imp} was estimated to be 56.4 acres. The remaining 15.3 acres of the wetlands tributary area was assumed to be till grass. This resulted in a V_r of approximately 93,200 ft^3 and a V_b/V_r ratio of 0.3.

Step 3 – Mass of Pollutants Removed by South Lot Facilities

The final calculation step involves calculating the mass of pollutants removed by the south lot facilities. The mass removed, MR, is based on the actual loadings calculated in Step 2 multiplied by the percent treated, %Trt, and the treatment efficiency, %Eff:

$$MR = AL \times \%Trt \times \%Eff \qquad \text{Eq. 5}$$

The percent treated variable accounts for the percent of the stormwater volume diverted to the facility (%Div) which is actually expected to receive treatment. In the daylight alternative, this translates to the percent of the volume in the channel which accesses the middle terrace. For the non-deformable daylighting scenario, hydraulic analysis using Manning's Equation was performed to estimate the flow required to produce a water surface elevation of 0.6 feet, which would begin to top the middle terrace. Given the channel assumptions listed above, this flow rate is approximately 4 cfs, which has an estimated recurrence interval of roughly 1 to 2 months. This recurrence interval range was interpolated from the 2-year, 25-year, and 100-year estimates from the flow control plan (Entranco, 2000) and is intended to provide only a very rough estimate. From Resource Planning Associates (1989), this recurrence interval range would correspond to roughly 65 percent of the annual stormwater volume. Conversely, it may be expected that 35 percent of the annual stormwater volume reaches the elevation of the middle terrace. This percentage of the stormwater volume was further refined to account for the percent which actually contacts the vegetated floodplain by the ratio of floodplain width to total cross-sectional width, estimated to be approximately 60 percent. Thus, approximately 20 percent of the annual stormwater volume which enters the non-deformable channel is expected to receive treatment within the floodplain.

For the deformable channel, given the assumptions noted above and using the same procedure as for the non-deformable channel, an estimated 5 percent of the annual stormwater volume which enters the deformable channel is expected to receive treatment within the floodplain. This represents the product of an estimated 20 percent of the volume which engages the floodplain and of that, 17 percent percent contacts the vegetated floodplain. This actual product was rounded up to 5 percent.

For the hybrid and NDS alternatives, it was assumed that final designs would provide treatment for 90 percent of the stormwater diverted to the facilities. This level of treatment should be verified once final designs are completed.

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